Testimony for the Committee on Science
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Chairman Smith, Congresswoman Johnson, Congressman McCaul, I thank you for the opportunity to comment on the subject of Innovation and Information Technology, and more specifically on the Government, University and Industry roles in IT research and commercialization.

There is overwhelming evidence, and a strong consensus among leaders in science and technology worldwide, that the broad range of disciplines and technologies encompassing information technology will be of critical importance to the industrialized world during the 21st century. Progress and prosperity in America will be greatly affected by the components of information technology, which include computational and computer engineering and science, high performance computing, simulation, high-bandwidth networks, high-volume data storage and management, computational visualization, and their underlying scientific and technological disciplines. Information technology will affect virtually every aspect of modern life; it will influence the welfare, security, and quality of life of every American as well as other citizens of the planet, and it will change the way information is distributed, represented, and manipulated. It will be a crucial factor in industrial competitiveness, a fundamental pillar of modern science and engineering, and a transforming factor in business, education, science, communication, medicine and virtually every technological enterprise.

The evidence is compelling. Over the last 10 years or so, few areas of science and technology have had such a profound impact in society and the world as information technology, and none has effected these societal changes at a faster pace. And we are, no doubt, just at the beginning of one the most significant and deeply transforming revolutions in human history.

Chairman Smith has put forward a set of key questions to be addressed during this hearing. In what follows, I attempt to respond to these questions from the perspective of an educator, researcher and administrator at a public research university.

- **How does the federal investment in information technology research promote innovation in information technology and foster the development and commercialization of new applications?**

Federal investment in information technology played a critical role in launching the wave of innovation that we have experienced in the last 10 years in business, education, communications, and research and development across all disciplines. This federal investment is what sustains a vibrant community of scholars and researchers at universities across the nation; a community that created, among other things, the first web browser at the University of Illinois, and the Google search algorithm at Stanford, both of which, in Thomas Friedman analysis, were key factors in "flattening" the world. The return on the investment, even to a casual observer, has been extraordinary.

Equally important is the impact of the federal investment in information technology research into virtually every field of science and engineering. In fact, this investment affects almost every aspect of the federal research portfolio and, directly or indirectly, promotes innovation across the entire science and engineering spectrum. A well-balanced information technology research portfolio is thus critical to national competitiveness in the 21st century.

- **What role does university research play in innovation in information technology? How do University balance federal and industry support for research projects? What are the barriers to the use of university results in commercialization of new information technology products?**

Historically, research universities in the U.S. have led the way in innovation in all areas of technology, and information technology is no exception. There are, however, unique aspects of information technology -- such as its strong multidisciplinary nature, rapid pace of evolution and societal impact -- that demand new approaches to research and education. In fact, many universities across the nation have begun to restructure their academic programs in preparation for this information revolution.

At The University of Texas at Austin, research and education in information technology, Computer Sciences, Computer Engineering and Computational Science and Engineering are of the highest priority. Over the last several years, the University has made important investments in its physical infrastructure, upgraded its computational capacity, hired world-renowned faculty, and created and strengthen graduate programs and research centers. I should stress that this investment has been matched by major contributions from private individuals, industry, and the Federal government. The Federal investment has been in the form of major research grants awarded to the University by, primarily, the National Science Foundation, the Department of Defense, the Department of Energy, and NASA.

Our Texas Advanced Computing Center has established strong partnerships with several industry leaders in information technology, which have resulted in the deployment of major computational resources. This computing capability benefits researches on campus, across Texas and the Nation. Last year, the Texas Advanced Computing Center joined NSF's TeraGrid, which is the world's largest, most comprehensive distributed cyberinfrastructure for open research. Researchers at the Center are also actively developing and deploying new software technologies that help connect and aggregate advanced computing systems, such as High Performance Computing, storage, visualization, networks, etc., into powerful computational Grids.

At the same time, at our Institute for Computational Engineering and Science, faculty, students and researchers are using this powerful cyberinfrastructure to develop the next generation of applications that will ensure the Nation remains at the cutting edge of innovation. One example of these applications include predictive modeling of cardiovascular bypass surgery, no doubt breaking new ground in the emerging field of Simulation Based Medicine. Developments like these promise to revolutionize future medical practice. There are many more examples of applications being developed at universities and at national and industrial laboratories across the nation that will have profound, perhaps unimaginable impact on all areas of science and engineering.

In fact, we are witnessing the emergence of a new field that the community has named "Simulation Based Engineering and Science." The concept is not necessarily new, since it is practiced in many engineering disciplines, except that we are now evolving towards the *pervasive* use of simulation and high performance computing to predict, with high degree of confidence, the outcome of the most complex biological, geophysical, engineering, scientific, behavioral, and social processes.

- **What areas of information technology research and what type of programs should the federal government support to maintain U.S. competitiveness? How do these areas complement the focus and investments of industry research programs?**

Major planned investments by the National Science Foundation in cyberinfrastructure will no doubt provide the next generation of computational platforms critical to keeping the Nation competitive at the international level and at the cutting edge of information technology. And the consensus among the experts is that the investment has to be sustained and long term in order for us to gain, and some will say regain, unquestionable leadership in information technology. It is clear, however, that the investment in cyberinfrastructure must be matched by an equally aggressive support of the research that will create the applications running in those platforms. So, I would like to join many of my colleagues in recommending the creation of a long-term, high-risk research program in Simulation Based Engineering that cut across all directorates of NSF and other Federal agencies. Such program will not only develop the computational tools that will be indispensable in the 21st century, but they will help produce the next generation of multidisciplinary scientists and engineers who will ensure the nation remains at the cutting-edge of scientific discovery.

Such a crosscutting, multi-agency program in Simulation Based Engineering will help to bring balance to the federal investment in information technology. However, I would like to point out that a third aspect of the federal investment in information technology is in need of immediate attention, namely, the dearth of federal programs aimed at the development of the next generation of software and hardware technologies that achieve high performance on thousand of computational nodes, that are easy to program and that tolerate failure of individual components when running applications spanning thousands of processors for many days or weeks. The DARPA High Performance Computing Systems (HPCS) program, in partnership with several federal agencies, is to be commended for funding such research and development program. I would submit to the Committee that a significant increase in the level of funding of programs such as DARPA's HCPS is needed to properly balance the Nation's research portfolio since, by and large, the market currently does not reward companies for long term, high-risk research in this area.

Federal investment in three critical areas of information technology – cyberinfrastructure, simulation based engineering and science, and next generation software and hardware technologies – are well aligned with the President's American Competitiveness Initiative ant the principles behind the initiative. In paticular: 1) the federal government will be fulfilling its responsibility to fund long term, high risk research; 2) advances in information technology will continue to have a major impact, and on a relatively short time frame, on the Nation’s economic competitiveness; and 3) the tools developed by information technology research will have a direct impact in the advancement of all disciplines, including engineering and the physical sciences.